

tion of Aphides; on the biology and morphology of Aphides; on the antiquity of the Hemiptera, and particularly with regard to the Aphidinae as represented in the sedimentary rocks and in amber; diagnoses of the Aphides found in amber are given, with figures; and we have also an account of those known to occur in a fossil state in America. Directions for the mounting and preservation of Aphides are given, and we find a very complete bibliography of authors who have treated about Aphides, and a very excellent general index.

In conclusion it only remains for us to congratulate the author on the very successful accomplishment of this important work, which is certain to excite an interest in this marvellous group of insects, and the Ray Society on being the medium of publishing the most beautifully illustrated work on the Aphides that has as yet appeared.

EARTHQUAKES AND BUILDINGS

A COMPLETE discussion of the effects which earthquakes produce upon buildings would form a treatise as useful as it would be interesting. Not only would it involve a discussion of the practical lessons to be derived from the actual effects of earthquakes, but it would include deductions based on our present knowledge of the nature of earthquake motion. Such knowledge is obtained from the records of seismographs.

In the following few notes I intentionally overlook this latter portion of the subject, and confine myself to a few of the more important practical conclusions respecting the effect of earthquakes on buildings, which may be of value to those whose mission it is to erect buildings in earthquake countries.

With regard to the situation of a building, it is sometimes observed that after an earthquake it is the portion of a town situated on low ground which has principally suffered, whilst adjoining portions on hills may have practically withstood the disturbance. In 1855 this was the rule governing the distribution of ruin in Tokio. The reverse, however, has been the rule in Yokohama. Speaking generally on this point it may be said that there is no universal rule,—each small area in an earthquake region having its special rule. As a site for a building, theory seems to indicate that soft earth or marshy ground, which would absorb much of the momentum communicated to it, and therefore act as a buffer between a building and a shock approaching through other strata, would prove a safe foundation. This seems also to have been an old opinion, for we read that the temple of Diana was built on the edge of a marsh to ward off the effects of earthquakes, but experience has repeatedly shown us, as in the case of Tokio and Manila, that swamp-like ground, as an earthquake palliative, has but little effect. On the other hand, hard rocky strata, where the amplitude of motion is small, but the period quick as compared with the motion in the inelastic material of the plains, has, as was markedly illustrated in 1755 at Lisbon, and in 1692 at Jamaica, proved the better foundation. Places to be avoided are the edges of cliffs, scarps, and cuttings. For emergent waves, these are free surfaces, and from their faces materials are invariably shot off, much in the same way that the last car in an uncoupled train of carriages may be shot forward by an engine bumping at the opposite end.

As foundations for a building there are two types. In one, which is the European method of building, the structure is firmly attached to the ground by beds of concrete, brick, and stone. In the other, which is illustrated in the Japanese system of building, the structure rests loosely on the upper surface of stones or boulders. As an indication of the relative value of these two forms of building, it may be mentioned that in Yokohama, in 1880, many of the European buildings were more or less

shattered, whilst in the Japanese portion of the town there was no evidence of disturbance.

The houses, like the foundations, are also of two types. In the European house built to withstand earthquakes, of which there are examples in Tokio and San Francisco, and for which in America patents have been granted, we have a building of brick and cement bound together with hoop iron and numerous tie rods. A building like this, which from time to time is jerked backwards and forwards by the moving earth, to which it is secured by the firmest of foundations, is expected to resist the suddenly-applied and varying stresses to which it is exposed by the strength of its parts. This type of structure may be compared to a steel box, and if its construction involves any principle, we should call it that of strength opposing strength. Some of the buildings in Caraccas, which are low, slightly pyramidal, have flat roofs, and which are bound along their faces with iron, belong to this order. These so-called earthquake-proof buildings, with the exception of their chimneys, have certainly satisfactorily withstood small earthquakes in Japan. As to how they would withstand a disturbance like that at Casamicciola is yet problematical. Unfortunately these structures are very expensive.

The second type of building may be compared to a wicker basket. This is certainly as difficult to shake asunder as the steel box type, and at the same time is not so expensive. The Japanese house belongs to this type. It is largely used on the west coast of South America; and in Manila, since the disaster of 1880, it has rapidly been replacing the heavy stone form of structure. Briefly, it is a frame house with a light roof of shingle, felt, or iron. As put up in Japan, its stability chiefly appears to depend on the fact that it is *not* firmly attached to the earth on which it rests, and that its numerous joints admit of considerable yielding. The consequence is that, whilst the ground is rapidly moving backwards and forwards, the main portions of the building, by their inertia and the viscous yielding of their joints, remain comparatively at rest.

A house that my experience suggests as being aseismic, and at the same time cheap, would be a low frame building, with iron roof and chimneys supported by a number of slightly concave surfaces resting on segments of stone or metal spheres, these latter being in connection with the ground. Earthquake lamps, which are extinguished on being overturned, would lessen the risk of fire, while strong tables and bedsteads would form a refuge in case of sudden disturbances.

In earthquake towns the streets ought to be wide, and open spaces should be left, so that the inhabitants might readily find a refuge from falling buildings. Brick chimneys running through a wooden building, unless they have considerable play and are free from the various portions of the building, are exceedingly dangerous. In consequence of the vibrational period of the house not coinciding with that of the chimney, the former by its sudden contact with the latter when in an opposite phase of motion almost invariably causes an overthrow. In 1880 nearly every chimney in the foreign settlement in Yokohama was overthrown in this manner, and the first alarm inside the houses was created by a shower of bricks falling on beds and tables. Since this occurrence the chimneys in Yokohama have had more or less play given to them where they pass through the roofs.

Chimneys with heavy tops, like heavy roofs, must be avoided. Another point requiring attention is the pitch of a roof. If this is too great, tiles or slates will be readily shot off. Archways over openings should curve into their abutments, otherwise, if they meet them at an angle, fractures are likely to be produced.

If for architectural reasons, or as a precaution against fire, it is necessary to have buildings which are substantial, their upper portions ought to be as light as is

consistent with the requisite strength. Hollow bricks, light tiles, with *papier-maché* for internal decorations, have been recommended as materials suitable for super-structures. At the present time the city of Manila, partly through Government interference, and partly through the desire of the inhabitants to reduce the chances of farther disasters, presents a singular appearance of light super-structures rising from old foundations. Iron roofs are visible in all directions, whilst on the massive basements of old cathedrals and churches upper stories of wood, with cupolas and spires of corrugated iron, have been erected.

Although the suggestions embodied in the above notes are few in number, it is hoped that they may be of some practical value. Without extending them, they show us that, even though we may not be in the position to escape from earthquakes by forewarning ourselves of their approach, we can at least mitigate the effects of these disasters by proper construction.

JOHN MILNE

Tokio

THE LATE ERUPTION OF VESUVIUS

OUR visit to the crater of Vesuvius on January 11, 1884, was a most interesting one. In my former letter I gave the rough details of this new eruption as well as could be ascertained from the base of the cone. The lava that issued on Tuesday night continued to flow till Wednesday evening, but seemed to have arrested its progress about 10 o'clock that night, when I was in the Atrio del Cavallo. This stream proved to have welled out at the base of the little cone of eruption and to have flowed across the solid lava plain in the crater of 1872, and then to have poured down the north-north-west slope of the cone till it reached the Atrio, across which it extended but little. Within the crater of 1872 we have a somewhat convex plain of lava, which is continuous with, or, more properly, overlaps, the crater edges, except for a short distance on the south-south-west side. The north-east part of this is covered by the remnants of the crater of January, 1882. Within this were a series of crater rings that have since filled up to a certain extent the cavity of 1882. For some time the vent has travelled south, so that the present cone of eruption overlaps the crater ring of January, 1882, on its south side, whereas there is a deep crescentic fossa between the present cone and the north crater ring of two years since. The vent was giving forth great volumes of vapour, and there was an almost continuous fountain of fragments of molten lava, which often attained the height of one or two hundred yards. As a consequence much filamentous lava, often as fine as cotton, was raining around the crater, and as we sat there eating our lunch, it was so covered with these rock fragments, that it required a long climb on foot to make such a gritty meal palatable. The ejectamenta are composed solely of lava in detached pieces, ejected in a plastic state with a few bombs, consisting of older solid lava fragments partially fused and rounded on the surface, which is varnished irregularly by the fluid magma that enveloped them. This indicates that the lava is very near the top of the chimney, which must be full, as it has been for some time. Photography was no easy matter amidst this fiery bombardment, for such was the abundance of the ejectamenta that we could see how rapidly the cone of the eruption was growing. I made a rough calculation of the quantity of new material expelled, and I think six cartloads in four seconds as quite a fair estimate. The lava that had flowed was solid and cold enough to allow my dog to cross it with ease, though through a few cracks it was seen to be still incandescent, and a green staff thrust in immediately blazed. The lava that was flowing in the direction of Pompeii is still doing so in one or two points, apparently at the same rate and place as two weeks since.

Altogether this eruption seems to be of very little importance, and during the last four years there have been many similar ones. Prof. Palmieri, in the *Corriere del Mattino* of January 11, prophesies a great eruption, but on what grounds it seems difficult to make out. No one would deny that such could occur and is not improbable; but there seems to be no more reason now than two months since.

The smoke or vapour yesterday had, when seen by reflected light, the same colour as usual, namely, a salmon tint. The sky was very clear, and I looked at the sun through this vapour, bearing in mind the recent remarkable sunsets and green suns. The transmitted light ranged from a *burnt sienna* brown to a dirty orange, having much the same colour as when we look through a dark London fog. I noticed that the light that traversed the vapour column and fell on the opposite escarpment of Monte Somma was of a colour that would be obtained by mixing a mauve with about equal quantities of brown.

Naples, January 13

H. J. JOHNSTON-LAVIS

THE EGYPTIAN SUDAN AND ITS INHABITANTS

AS some degree of vagueness seems still attached to the term Sudan, it may be well to state at once that it is simply the Arabic equivalent of the older and more intelligible expressions, Nigritia, Negroland, which have in recent times somewhat unaccountably dropped out of use. In its widest sense it comprises the more or less fertile zone lying between the Atlantic on the one hand and the Red Sea and Abyssinian Highlands on the other, and stretching from the Sahara and Egypt Proper southwards to the Gulf of Guinea, and the still unexplored Central Equatorial regions, and further east to Lakes Albert and Victoria Nyanza. This vast tract, which may on the whole be regarded as the true domain of the African Negro race, is commonly and conveniently divided into three great sections:—(1) *Western Sudan*, comprising roughly the basins of the Senegal and Quorra-Binue (Niger) with all the intervening lands draining to the Atlantic; (2) *Central Sudan*, comprising the basins of the Komadugu and Shari with all the lands (Kanem, Bornu, Baghirmi, Wadai) draining to Lake Chad; (3) *Eastern Sudan*, comprising everything east of Wadai, that is mainly the Upper and Middle Nile basin.

Politically, this third section, with which alone we are here concerned, has for some years formed part of the Khedive's possessions, hence is now more generally known as *Egyptian Sudan*. Until 1882 it formed a single administrative division under a Governor-General resident at Khartum. But in that year a sort of Colonial Office was created for this region, which was placed under a Cabinet Minister and broken up into four separate departments or divisions, each under a Hukumdar, or Governor-General, directly responsible to the Minister for Sudan at Cairo. The various provinces hitherto forming the single administration of Egyptian Sudan thus became distributed as under:—

WEST SUDAN, comprising Darfur, Kordofan, Bahr-el-Ghazal, and Dongola, with capital Fasher.

CENTRAL SUDAN, comprising Khartum, Senaar, Berber, Fashoda, and the Equator (Hat-el-Istwa), with capital Khartum.

EAST SUDAN, comprising Taka, Suakin, and Massowah, with capital Massowah.

HARRAR, comprising Zeyla, Berbera, and Harrar, with capital Harrar.

The complete development of this scheme has been somewhat rudely interrupted by the successful revolt of the "Mahdi," who has for the moment wrested the greater part of the country from Egyptian control. But should this arrangement be carried out after the restoration of order, a further element of confusion will be introduced